

What is claimed is:

1. An optical apparatus comprised of :

an array of optical grating couplers fabricated on a substrate and
an array of optical devices,
where the array of optical grating couplers is optically aligned to the
array of optical devices.

2. An optical apparatus of Claim 1, wherein the array of optical grating couplers and the array of optical devices is secured by mechanical attachment..
3. An optical apparatus of Claim 1, wherein the array of optical devices is comprised of one or more arrayed elements from the list including: VCSELs, lasers, detectors, surface emitting lasers, light emitting diodes, super luminescent diodes, modulators, filters, fibers, fiber components, lenses, diffractive lenses, grating couplers, optical amplifiers, mirrors, and/or resonant cavities.
4. An optical apparatus of Claim 1, wherein the substrate is formed from one or more of the following material systems: a silicon substrate, a silicon on insulator substrate, an indium phosphide substrate, a gallium arsenide substrate, and/or a germanium substrate.
5. An optical apparatus of Claim 2, wherein the securing mechanical attachment comprises a plurality of electrical connections between the array of optical devices and the substrate.

6. An optical apparatus of Claim 5 wherein at least one of the plurality of electrical connection is comprised of C4 solder commonly involved in commercial bump bonding operations.
7. An optical apparatus of Claim 5 wherein at least one of the plurality of electrical connections is comprised of a gold bump commonly involved in commercial flip-chip operations.
8. An optical apparatus of Claim 5 wherein the plurality of electrical connections is coupling a plurality of transistors formed on the substrate and the array of optical devices.
9. An optical apparatus of Claim 8 wherein the plurality of transistors supply electrical signals to the array of optical devices.
10. An optical apparatus of Claim 8 wherein the plurality of transistors is used to sense and process electrical signals from the array of optical devices.
11. An optical apparatus of Claim 8 wherein the plurality of transistors is formed with a CMOS process.
12. An optical apparatus of Claim 1 wherein the mode field of the array of optical grating couplers is designed to match the mode field of the array of optical devices.
13. An optical apparatus of Claim 1 wherein the plurality of output signals of the array of optical grating couplers comprises a plurality of output signals of a wavelength demultiplexing device.
14. An optical apparatus of Claim 2 wherein the mechanical attachment is formed by a wafer bonding process.
15. An optical apparatus of Claim 2 wherein the mechanical attachment is formed by fabricating the array of optical devices on top of the substrate.

16. An optical apparatus comprised of :

a plurality of optical grating couplers fabricated on a substrate and
a plurality of optical devices,
where the plurality of optical grating couplers is optically aligned to the
plurality of optical devices.

17. An optical apparatus of Claim 16, wherein the plurality of optical
grating couplers and the plurality of optical devices is secured by
mechanical attachment..

18. An optical apparatus of Claim 16, wherein the plurality of optical
devices is comprised of one or more arrayed elements from the list
including: VCSELs, lasers, detectors, surface emitting lasers, light
emitting diodes, super luminescent diodes, modulators, filters, lenses,
diffractive lenses, grating couplers, optical amplifiers, mirrors, and/or
resonant cavities.

19. An optical apparatus of Claim 16, wherein the substrate is formed
from one or more of the following material systems: a silicon
substrate, a silicon on insulator substrate, an indium phosphide
substrate, a gallium arsenide substrate, and/or a germanium substrate.

20. An optical apparatus of Claim 17, wherein the securing mechanical
attachment is comprised of a plurality of electrical connections
between the plurality of optical devices and the substrate.

21. An optical apparatus of Claim 20 wherein at least one of the plurality
of electrical connection is comprised of C4 solder commonly involved
in commercial bump bonding operations.

22. An optical apparatus of Claim 20 wherein at least one of the plurality of electrical connections is comprised of a gold bump commonly involved in commercial flip-chip operations.
23. An optical apparatus of Claim 20 wherein the plurality of electrical connections is coupling a plurality of transistors formed on the substrate and the plurality of optical devices.
24. An optical apparatus of Claim 22 wherein the plurality of transistors supply electrical signals to the plurality of optical devices.
25. An optical apparatus of Claim 22 wherein the plurality of transistors is used to sense and process electrical signals from the plurality of optical devices.
26. An optical apparatus of Claim 22 wherein the plurality of transistors is formed with a CMOS process.
27. An optical apparatus of Claim 16 wherein the mode field of the plurality of optical grating couplers is designed to match the mode field of the plurality of optical devices.
28. An optical apparatus of Claim 16 wherein the plurality of output signals of the plurality of optical grating couplers comprises a plurality of output signals of a wavelength demultiplexing device.
29. An optical apparatus of Claim 17 wherein the mechanical attachment is formed by a wafer bonding process.
30. An optical apparatus of Claim 17 wherein the mechanical attachment is formed by fabricating the plurality of optical devices on top of the substrate.
31. An optical apparatus comprised of:

an array of optical grating couplers formed on a first substrate,
an array of optical devices formed on a second substrate, where the first substrate is a silicon on insulator substrate and the second substrate is an indium-phosphide based substrate and where the substrates are mechanically fixed in optical alignment.

32. A method for attaching an array of optical devices to an array of optical grating couplers formed on a substrate, comprising the steps of:

placing a plurality of alignment marks on the substrate,
aligning the first of the array of optical devices to the first of the array of optical grating couplers,
aligning the last of the array of optical devices to the last of the array of optical grating couplers,
and
attaching the array of optical devices to the array of optical grating couplers.

33. The method of claim 32, wherein each step of aligning further comprises the step of:
using a vision system with a pattern recognition for automated alignment.

34. The method of claim 32, wherein each step of aligning further comprises the step of:
using a plurality of mask alignment marks on a plurality of masks used to fabricate an array of optical devices for alignment.

35. The method of claim 32, wherein each step of aligning further comprises the step of:
sending a plurality of optical signals via a plurality of waveguides in the substrate to the array of optical grating couplers,
detecting a plurality of optical output signals from the array of optical grating couplers,
and
aligning the array of optical devices to maximize the magnitude of the plurality of the optical output signals from the array of optical grating couplers.

36. The method of claim 32, wherein each step of aligning further comprises the step of:
sending a plurality of electrical signals to an array of light sources,
detecting a plurality of optical output signals from the array of light sources, using an array of optical grating couplers on the substrate,
and
aligning the array of light sources to maximize the magnitude of the plurality of the optical output signals from the array of light sources.

37. An optoelectronic circuit integrated on a substrate for converting a plurality of optical signals to a plurality of electrical signals,
comprising:

a plurality of planar waveguides providing the plurality of optical signals at a plurality of output ports,

an array of optical grating couplers, with a plurality of input ports coupled to the output ports of the plurality of waveguides,
and

an array of photodetectors, with each of the photodetectors coupled to a separate output of one of the array of optical grating couplers, and each photodetector generating an electrical output signal in response to the detected optical signal.

38. An optoelectronic circuit integrated on a substrate for converting a plurality of electrical signals to a plurality of optical signals, comprising:

a plurality of electrical signal lines providing a plurality of electrical signals,

an array of light sources, with each of the light sources coupled to a separate one of the plurality of electrical signal lines, and each light source generating an optical output signal in response to the received optical signal.

39. An optoelectronic circuit integrated on a substrate for electrical signal distribution, comprising:

a light source for generating an optical signal at an output port in response to a received electrical signal,

an optical grating coupler with an input port coupled to the output port of the light source, and with an output port,

a light splitting planar waveguide device, comprised of a waveguide and a light splitter, with an input port coupled to the output port of the optical grating coupler, and with a plurality of output ports,
an array of optical grating couplers, with each input port coupled to a separate one of the plurality of output ports of the light splitting planar waveguide device, and with a plurality of output ports,
and
an array of photodetectors, with each photodetector coupled to a separate one of the outputs of the array of optical grating couplers, and where each photodetector generates an electrical signal in response to the detected optical signal.